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January 26, 2010

(VIA ELECTRONIC FILING)

Marlene H. Dortch
Secretary
FEDERAL COMMUNICATIONS COMMISSION
445 12th Street, SW
Washington, D.C. 20554

Re: GN Docket Nos. 09-47, 09-51 and 09-137 (Spectrum for Broadband)
Written *Ex Parte* Communications

Dear Ms. Dortch:

The purpose of this letter is to disclose an *ex parte* communication in the form of the attached Supplemental Comments. The Supplemental Comments respond to questions raised by Nick Sinai, Energy and Environmental Director, and Charles Worthington, Energy and Environmental Staff of the Commission's National Broadband Taskforce, during two meetings On-Ramp Wireless, Inc. had with them—a telephone conference on October 14, 2009 and a meeting at the Commission's offices on December 17, 2009. Letters disclosing these *ex parte* communications have previously been filed with the Commission.

Respectfully submitted,

Kenneth G. Hurwitz
Attorney for On-Ramp Wireless, Inc.

cc: (via e-mail)
Nick Sinai
Charles Worthington
Joaquin Silva
Dr. Theodore Myers

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

In the Matters of

Inquiry Concerning the Deployment of Advanced Telecommunications Capability to All Americans in a Reasonable and Timely Fashion, and Possible Steps to Accelerate Such Deployment Pursuant to Section 706 of the Telecommunications Act of 1996, as Amended by the Broadband Data Improvement Act	)	GN Docket No. 09-137
A National Broadband Plan for Our Future	)	GN Docket No. 09-51
International Comparison and Survey Requirements in the Broadband Data Improvement Act	)	GN Docket No. 09-47

SUPPLEMENTAL COMMENTS OF
ON-RAMP WIRELESS, INC. – NBP PUBLIC NOTICE #2

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SUPPLEMENTAL COMMENTS OF
<u>ON-RAMP WIRELESS, INC. – NBP PUBLIC NOTICE #2</u>

I. INTRODUCTION

On-Ramp Wireless, Inc. ("On-Ramp") hereby submits supplemental comments in the above-captioned proceedings. On-Ramp originally submitted comments in these dockets on October 2, 2009 to address the advanced communications infrastructure and services necessary to achieve implementation of Smart Grid technology. Since that time, On-Ramp has been in communication with Commission staff[1] and wishes, by means of these supplemental comments, to respond to questions Staff raised, in particular whether it would make sense to establish a national machine-to-machine network to supply wireless services to serve numerous vertical applications of national policy interest (the "National Interest Service Verticals"). National

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1 *See* October 16, 2009 and December 18, 2009 disclosures of *ex parte* communications that were submitted on On-Ramp's behalf in the above dockets.

Interest Service Verticals suitable for a machine-to-machine wireless network include health care applications, such as blood glucose monitoring; gas and water utility infrastructure monitoring, to detect pipeline leaks; critical infrastructure applications, such as cargo container monitoring and tracking; security applications, such as first responder tracking; and others, including Smart Grid applications, to be discussed below.

In these supplemental comments, On-Ramp answers Staff's question emphatically in the affirmative. A national managed network is critical to enable these National Interest Service Verticals to develop and grow since many of the beneficiaries of such a network lack the expertise or resources to manage such a network on their own. Additionally, the cost to deploy and manage a high reliability wireless network may be prohibitive for many important applications (or at least delay their launch) unless the cost is spread over several applications by a network operator. Therefore, a national operator is critical to the development of these applications and will speed their time to market and enable the nation to enjoy their benefits.

On-Ramp also provides a detailed explanation of why its Ultra-Link Processing™ ("ULP") technology is ideal from a technological and economic perspective to serve the National Interest Service Verticals. Before turning to that explanation, it is useful to lay down the elements of the foundation that supports the foregoing positions. First, to efficiently address the wireless communications needs of the National Interest Service Vertical applications, it is imperative to understand the data networking characteristics and application performance requirements common to them. As discussed below, the applications and devices included in the National Interest Service Verticals require relatively small amounts of data to be reliably communicated through a managed network that supports battery operated endpoints, and can tolerate moderate latency.[2] Second, it is essential that these communications requirements be served by a wireless network that was purpose-built to serve them, not by other types of wireless networks whose technology was designed to serve vastly different requirements and therefore, would suffer crippling operational and performance constraints in the National Interest Service Verticals environment. As these comments will illustrate, other technologies, such as cellular and Frequency Hopping Spread Spectrum ("FHSS") (mesh), would be an inefficient and in many cases ineffective means of serving the National Interest Service Verticals' needs. Third, the National Interest Service Verticals themselves are so important from a national interest perspective that they must be served with a high degree of reliability, and in some instances, privacy and security. Finally, the wireless service to support the National Interest Service Verticals must be economically feasible. On-Ramp will demonstrate that its technology is scalable and offers low fixed costs of entry and low ongoing operating costs, characteristics that are absent in the case of competing wireless technologies, which are likely to prove infeasible for large-scale application because their costs will prove prohibitive.

By means of these supplemental comments, On-Ramp is requesting that the Commission allocate 8 MHz of spectrum, grouped in 4 MHz allocations to each of two wireless operators, on a geographic basis, to serve the National Interest Service Verticals. In making this request, On-Ramp recognizes that spectrum is a scarce commodity, subject to a myriad of competing demands, and must be conservatively and carefully allocated to potential users. On-Ramp will demonstrate in these comments that its technology, having been purpose-designed and built to

[2] Throughout these supplemental comments, we employ the term "National Interest Service Verticals" to refer only to those national interest applications that have the characteristics discussed above in the text. The term, as we employ it here, does not refer to include applications that require high data rates and are latency intolerant, such as voice and large-packet-size data communications.

serve the National Interest Service Verticals at issue, can do so with substantially greater spectral efficiency than the competition, which designed their networks to handle voice and high speed data communications systems, a class of applications with distinctly different data network requirements. To ensure that the goal of spectral efficiency is met, On-Ramp further recommends that only operators that use On-Ramp's ULP technology, or a technology capable of achieving comparable or superior spectral efficiency for the applications at issue, be eligible for a 4 MHz allocation.

II.
INTRODUCTION TO ON-RAMP

For convenience, it is useful to incorporate herein and expand upon the introduction to On-Ramp that was presented in its October 2, 2009 comments. Located in San Diego and managed by a team of professionals from the wireless, digital, defense and utility automation industries, On-Ramp has developed the first wireless system specifically designed to connect millions of hard-to-reach meters and sensors in challenging utility and industrial environments. Because it was built with this purpose in mind, it will work seamlessly with end-users of numerous applications sharing similar data networking requirements.

Today, On-Ramp is working with several companies on a global basis to implement its system, including (1) a public utility and a coalition of energy technology companies in California to implement a Smart Grid demonstration project for distribution automation and energy efficiency applications; (2) a company that is a global leader in utility automation systems with thousands of systems deployed for energy efficiency, smart metering and water grid automation across Europe, the Middle East, North America and Asia; (3) a company that is a global leader in broadband radio development and manufacturing with industry-leading market share; and (4) a company that is a global leader in location tracking systems for a metropolitan scale tracking solution supporting first responders, government and military personnel.

On-Ramp's technology employs Central Access Points in a star configuration to transmit and receive low-power signals directly communicating with Nodes embedded in the myriad of sensors and customer meters in urban, suburban, ex-urban or rural environments. The Central Access Points, in turn, communicate bi-directionally with a variety of third-party product platforms.[3] The Central Access Points and Nodes use ULP technology, a high-receptivity signal processing innovation developed by On-Ramp that is capable of wide-area coverage and is immune from all but high levels of interference, at a significantly lower cost and with far greater capacity, efficiency and system security than existing and proposed wireless mesh systems, and with coverage and reliability far superior to those offered by the commercial cellular network. Equipped with ULP technology, a single Central Access Point can cover an entire industrial site, a 50-story office building or an entire small metropolitan area. On-Ramp's website, www.onrampwireless.com, sets forth additional background on the company and its announced projects.

III.
COMMENTS

A. The National Interest Service Verticals Will Foster the Nation's Goals to Reduce Greenhouse Gas Emissions, Promote Energy Independence, Increase the Supply of Available Water, Protect Our Borders, Increase Patient Safety and Provide Numerous Other Benefits

In this section, On-Ramp will discuss examples of the National Interest Service Verticals—service verticals that share certain communications characteristics and requirements in common—that could be provided efficiently and effectively by the On-Ramp wireless system.

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3 The backhaul communications by the Central Access Points can be made via a variety of media, including for example the commercial cellular network, T1 lines and satellite communications.

Implementing these verticals, *i.e.*, applications, within the next several years plainly is in the National interest. For convenience, in these comments On-Ramp will limit the discussion to applications that promote energy efficiency (and thereby reduce Greenhouse Gas emissions), foster public health, enhance national security or preserve natural resources, but it bears emphasis at the outset that there are numerous other applications that fit within these categories.[4]

Turning first to energy efficiency, it is estimated that the commercial building sector consumes 20 percent of the Nation's energy and that the average commercial building could reduce energy use by up to 20 percent by more precisely controlling lighting and HVAC systems. Wireless controls would enable these systems to be coordinated with time-of-day information or paired with motion sensors to operate only when needed at a fraction of the cost of wired solutions. In addition, remote monitoring of HVAC systems can be used to optimally schedule maintenance. Sensors placed in on-site equipment could wirelessly transmit the pertinent information, which involves a minimal amount of data, to a processor and wirelessly receive binary (*i.e.*, "on-off") or similarly uncomplicated instructions to control the appliance. Furthermore, by cost effectively aggregating millions of square feet of commercial office and industrial space representing thousands of kilowatts of load, On-Ramp can enable utilities to offer demand response solutions to reduce peak demand and the need to expand generation and transmission capacity. Implementing these commercial building applications would plainly be in

[4] Other applications, in addition to those discussed below, that should be included in the National Interest Service Verticals category for which an allocation of spectrum is appropriate include core, mission-critical Smart Grid applications such as distribution grid repair and control and critical end-user support (such as support for military bases and data centers); infusion pump monitoring; natural gas meter information and thermostat control; water meter demand response; sewer monitoring; monitoring of the structural integrity of bridges; soil monitoring; oil and gas pipeline monitoring; public transport tracking; railroad condition monitoring; traffic congestion monitoring; gas and hazardous material detection; perimeter security; and border surveillance. Undoubtedly, many other applications will come into being in the future.

keeping with the one of the central purposes of the American Recovery and Reinvestment Act of 2009 ("ARRA"),[5] which is to "mak[e] supplemental appropriations for … energy efficiency ...."[6]

The same may be said of certain health applications, such as blood glucose monitoring, which ARRA generally endorses as a "technolog[y] that facilitate[s] home health care and the monitoring of patients recuperating at home."[7] For the 18 million people in the United States who are struggling with diabetes, it is extremely important that blood glucose levels be carefully monitored in order to determine the appropriate action to maintain healthy levels. Because large numbers of diabetes sufferers do not comply with doctor's instructions to regularly check blood glucose levels, society is forced to bear millions of dollars in health care costs to deal with the inevitable complications. One way to reduce this significant expense and enhance public health is to monitor compliance through blood glucose monitors that enable readings and trends to be wirelessly communicated to a health care professional who can then take steps to improve patient compliance and health. Again, as above, the data to be uploaded (*i.e.*, patient took a reading; patient did not take a reading; patient blood glucose readings) and downloaded (alarms; acknowledgements) are simple, consisting of small payloads that must be communicated reliably across large geographic areas without the intervention or knowledge of technology by the patient.

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5 Public Law No. 111-5, 123 Stat. 115 (2009).

6 Intelligent streetlight dimming and management applications also promote energy efficiency. By adding wireless control units to a streetlamp, operators can reduce energy costs by up to 35 percent through a combination of optimizing hours of operation, improving maintenance and dimming during off-peak traffic times. Furthermore, repair and maintenance costs can be reduced by 10 to 25 percent through burn-hour optimization and automatic notification of problematic units.

7 ARRA § 3002(b)(2)(C)(iv).

Promoting national security through cargo container monitoring is vital to the National interest in securing our borders.[8] Given the recent elevated threat of terrorist attack, it is more important than ever to monitor the estimated 11 million cargo containers that enter U.S. ports each year and provide a means of determining whether a container has been opened or compromised during transit. These functions cannot be performed manually due to the sheer number of containers. Wireless cargo container monitoring is a reliable and extremely cost effective method to gather and communicate this information by adding a security device to each container to transmit critical security data miles before the container has reached port. This can help "triage" the containers that require enhanced manual inspection. As with the other National Interest Service Verticals discussed in this section, the data requirements for uplinked information (tamper; no tamper) and downlinked instructions (alarms; acknowledgements) are minimal but nonetheless extremely challenging from a communications coverage perspective.

Natural resource conservation is also a national concern. Water, in particular, is becoming an increasingly precious commodity as demand continues to grow and prolonged droughts reduce supply, especially in the western region of the country. Unfortunately, as the Environmental Protection Agency ("EPA") has recognized,[9] this situation is compounded by the loss of much of the water piped through aging pipelines due to leakage; it has been estimated that as many as 7 billion gallons of drinking water are lost each day in the United States, with

[8] Congress enacted the Security and Accountability for Every Port Act, P.L. 109-347, in 2006 to address the problem of radiation in cargo containers; and the Container Security Initiative, a government-to-government antiterrorism effort, is one of a series of initiatives aimed at securing the supply chain.

Another security-related application that bears mention is first responder tracking. This application enables the monitoring of the location of firemen and other personnel at the site of an emergency.

[9] The EPA funded a study in 2009 entitled "Leak Detection and Wireless Telemetry for Water Distribution and Sewerage Systems." The study was conducted under the auspices of EPA's "Sustainable Infrastructure for Water and Wastewater" program.

significant losses affecting municipal and public water systems. Reducing these losses through the use of leak detection technology, which uses an acoustic sensor or other monitoring device to determine the occurrence and location of a leak, can increase the supply of usable water. Wireless communications enable sensors to transmit these data to a network processor that can, in turn, wirelessly transmit data to trigger shut-off of affected pipeline segments.

The potential benefits of these applications and the opportunity to enhance public health and welfare by adopting them are manifest. Moreover, because these applications, and many others, share common communications characteristics and needs, they cry out for a purpose-built wireless network that achieves a high level of spectral efficiency. Before discussing On-Ramp's technology in this context, it is appropriate to describe the National Interest Service Verticals' common characteristics and needs.

B. The National Interest Service Verticals Share Common Communications-Related Characteristics and Have Common Communications Needs

The National Interest Service Verticals applications, both individually and in the aggregate, would require the wireless provider to close communications links with hundreds of millions or even billions of devices, in a myriad of locations. Adding to the challenge, individual Nodes tend to be located in difficult and remote environments, such as in buildings or ships, below manhole covers or underground, or they can change their location. The second key characteristic of the National Interest Service Verticals is that each of them involves small packet-sized transactions[10] for both uplink and downlink, and can tolerate moderate latency. In other words, the amount of data per communication is small, and system latency can be seconds

[10] It is critical to note, however, that cumulative data flows will be extraordinarily large.

or minutes—compared to other applications, such as web navigation and cell phones, where any latency would severely degrade quality of service.[11]

What are the network requirements for the National Interest Service Verticals applications? The answer is high capacity (to handle the large cumulative data flows in light of the sheer number of devices and applications), low power demands (to prolong battery life, for as much as 20 years for remote sensors in locations where batteries cannot be recharged and grid power is unavailable or infeasible), and high resilience against interference (because of the ubiquity of other devices and the proximity of other networks).[12] Given the nature of the applications, high security and reliability are also required. And because available bandwidth for allocation is scarce, the wireless network must be spectrally efficient—in other words, the network must be able to operate at a high capacity-to-MHz-of-spectrum ratio.

Two conclusions flow from the above discussion. First, it makes eminent good sense to serve all of the National Interest Service Verticals with a wireless technology specifically designed to meet their common needs. Second, as a matter of spectrum management, it makes sense to group the National Interest Service Verticals together in a single category. On-Ramp is confident that the number and varieties of National Interest Service Verticals will multiply in the near future, so that they will serve an ever-increasing number of consumer-driven and public interest objectives.

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[11] To illustrate, an individual cargo container is either intact or not intact (uplink), the need to inspect it can be communicated through an alarm signal or other low-data signal (downlink), and data can be delivered within minutes as opposed to instantaneously without degrading the quality of service. Voice communications and "apps," on the other hand, involve substantially greater quantities of data, and must be communicated instantaneously.

[12] Even in licensed spectrum, there can be some level of adjacent channel (and co-channel) interference from other networks near the licensed bands.

C. Existing Technologies Are Inadequate to Meet the National Interest Service Verticals' Communications Requirements

Existing technologies, such as cellular, WIMAX, mesh and narrowband license spectrum solutions, were originally developed to address applications, such as voice and high speed data, with requirements fundamentally different from those set forth above. They are, thus—not surprisingly—unable to meet the requirements of the applications encompassing the target National Interest Service Verticals.

Turning first to cellular, the cellular system was originally optimized for voice and high-speed data applications, which involve very high data rates and use a substantial amount of bandwidth. Accordingly, the spectral efficiency of deploying cellular to serve low packet size transactions is very low. Moreover, the base station infrastructure needed to serve each application and customer would be very costly. As laptop and smart phone users become ubiquitous, and the entry of National Interest Service Verticals further crowds the field, more and more cellular base stations would be required to achieve the necessary high data rates. Additional equipment in the form of base stations and repeaters would also be required to close links with users in dead spots, in light of cellular's lower link budget. Adding infrastructure, however, is not a cure-all, since it cannot offset the inability of cellular to close links with devices located in especially challenging environments, such as underground or beneath manhole covers, and might not even be possible in certain necessary locations because of citizen "not-in-my-back-yard" resistance. When one also considers the short battery life of cellular devices, it becomes readily apparent that employing a cellular network for certain applications, such as pipeline leak detection and first responder monitoring, would present enormous quality of service obstacles.

WiMax, like cellular, was designed for high speed data and large downlink file transfers, and has similar performance (or lack of performance) characteristics. Like cellular, it consumes a considerable amount of power, is capacity-inefficient for small payload transactions, and is extremely expensive due to the high infrastructure costs associated with the necessity to deliver significant amounts of bandwidth. Also, like cellular, WiMax systems have relatively low receive sensitivity, which results in a small link budget, requiring substantial investment in additional base stations or repeaters to cover gaps, and cannot serve users or devices in underground locations, thus limiting its utility for certain types of National Interest Service Verticals, such as pipeline leak detection. Like cellular, it represents a serious mismatch to the needs of the National Interest Service Verticals.

Mesh systems differ from cellular and WiMax in their technical characteristics, but they too are seriously inadequate for serving the National Interest Service Verticals. First, they are incapable of wide area deployment and leave significant coverage gaps. Mesh networks depend on the existence of a dense infrastructure of powered repeaters to relay their signals throughout a geographic area. This required infrastructure is impractical to implement in many deployment environments. This factor alone effectively disqualifies mesh systems as candidates to serve the National Interest Service Verticals. Second, mesh systems are characterized by an extremely poor data throughput per MHz ratio (low spectral efficiency). This is due to the high capacity overhead they extract for processing and protocol management.[13] Increasing bandwidth for mesh systems is the only practical way to compensate, but doing so would be contrary to sound spectrum allocation policy. Third, mesh systems require costly infrastructure on a per

[13] Exhibit No. 1 compares the overhead needs of mesh systems with those of the On-Ramp ULP system. The last row of the exhibit also demonstrates the huge advantage of ULP in terms of spectral efficiency.

application and per customer basis, which implies prohibitive fixed costs of service as increasing numbers of service verticals penetrate the market and customer use increases. Finally, mesh systems cause extensive interference to other devices.[14] Taken together, these four factors militate against the widespread deployment of mesh, because mesh systems simply cannot be efficiently scaled up to meet the required service levels.[15]

Finally, narrowband license spectrum solutions are also not a viable option for a large-scale machine-to-machine network. They require a positive signal-to-noise ratio and perform poorly with any interference in the system (including co-channel and self-interference). Moreover, they are extremely capacity inefficient, and to operate require scheduled deterministic data flows, which are not possible for inherently *ad hoc* communications such as location tracking, patient diagnostics and peak load demand shedding in a building energy management system. Once again, as in the case of cellular, WIMAX, and mesh, the network solution offered by narrowband would not be adequate for the National Interest Service Verticals.

In short, the potential problems of building a nationwide network using existing technologies are enormous, especially given the magnitude of the opportunity to implement applications that are plainly in the public interest. The high deployment and maintenance costs these technologies would require to overcome their inefficiencies for the target applications, coupled with their poor reliability for critical applications, would foreclose innovation and retard

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14 Based on the analysis conducted by On-Ramp Wireless, a mesh-based AMI system operating in the 900 MHz ISM bands using a one watt transmit power requires a radio on time of up to 10 percent when performing critical network functions such as software firmware downloads or interactive meter reads, and would occupy the entire 20Mhz of the ISM band in this spectrum area. Due to the density of repeater, gateway and meter transmitters and radio on time, this in turn would raise the noise floor by 15-40 dB, which would result in the reduction of range of many Part 15 consumer devices by upwards of 2 to 10 times, rendering them useless for long periods of time.

15 *See* Exhibit No. 2, which illustrates the huge number of repeaters, dollar investment and additional spectrum that would be required to address only one subset of National Interest Service Verticals—meter reading for various utility services.

customer acceptance. These problems and gaps in existing technology did not escape the attention of the inventors of On-Ramp's ULP system, who have succeeded in designing, testing and deploying a network technology specifically designed to avoid them. We will now describe the On-Ramp system in some detail to demonstrate that it is ideal for meeting the network requirements for a nationwide machine-to-machine network to serve the National Interest Service Verticals.

D. Because of its Scalability and Low Power, the On-Ramp System Is Ideal for Meeting the Network Requirements of the National Interest Service Verticals

The On-Ramp system takes the well-known and industry-verified technology of Direct Sequence Spread Spectrum ("DSSS") used in CDMA systems to a new level of performance. Employing a new multiple access scheme called Random Phase Multiple Access, the On-Ramp system allows data from up to 1,000 Nodes to be simultaneously received at a single Central Access Point and yields superior throughput per MHz of channel allocation. Because the On-Ramp system uses DSSS, it maintains its superior throughput at a fixed uplink aggregate data rate no matter where the Nodes are placed—whether close to a Central Access Point or far away. The system is the only physical layer innovation in many years that has been field-proven to be capable of *efficiently* supporting the large-scale deployment of service applications that require minimal data transactions on a device-by-device basis, that are latency tolerant, and that must engage in two-way communications with millions of widely dispersed individual Nodes that are often found in hard-to-reach locations.

Efficiency in this context refers to three closely associated but separate phenomena: (1) the ability of a single Central Access Point in the On-Ramp system to close communications links, even while maintaining low output power, with thousands of dispersed Nodes in hard-to-reach locations; (2) the ability of a Central Access Point in the On-Ramp system to handle communications with a myriad of Nodes simultaneously; and (3) the On-Ramp system's ability to conduct these simultaneous communications within a small amount of spectrum allocation. The first and second of these criteria point to the low investment cost per customer of the On-Ramp system. The third criterion relates to efficient use of the spectrum. Taken together, a system that satisfies all three criteria is highly scalable. Unless a system is highly scalable, it will be unable to support the wide-scale development of a machine-to-machine network to support the National Interest Service Verticals.

1. The Efficiency of On-Ramp's Network System in Terms of Investment in Physical Plant—*i.e.*, Central Access Points

As stated above, the first criterion of efficiency is the ability of a single Central Access Point in the On-Ramp system to close communications links with thousands of dispersed Nodes in hard-to-reach locations while maintaining a long battery life of up to twenty years. The On-Ramp system satisfies this criterion.

Both the Nodes and the Central Access Points in the On-Ramp network system use ULP technology—a significant innovation in DSSS signal processing that results in very high receive sensitivity. The receive sensitivity of the system, which translates into a stark advantage in link budget over competing systems, offers extraordinary coverage, but also offers better resistance to interference and inherent link level security with far lower transmitter power levels.[16] On-Ramp estimates, for example, that by virtue of the high sensitivity of its receivers, only twenty-eight Central Access Point locations employing ULP would be necessary to enable the receipt of automatic meter information data from all electricity customers in the entire service territory of San Diego Gas & Electric Company, a 4,100 square mile area about the size of San Diego County, using spectrum in the 2.4 GHz band. This includes "worst-case scenario" receptivity—

16 On-Ramp's receiver sensitivity also enables On-Ramp to exert power control of its signals.

receptivity from meters in hard-to-reach locations, as well as devices inside buildings—one of the critical requirements of Smart Grid and certain other National Interest Service Verticals. With only twenty-eight Central Access Point locations necessary to cover such a large area, the On-Ramp system can also take advantage of favorable antenna locations, such as elevated Central Access Points, further enhancing the robustness of the system by a factor of ten. Taken together, the On-Ramp star topology configuration confers a 600-times coverage advantage over competing systems at equivalent antenna elevations and a far greater advantage when able to take advantage of antenna elevation.[17]

The second criterion of efficiency is the ability of a Central Access Point in the On-Ramp system to handle communications with a myriad of Nodes simultaneously. The On-Ramp system easily satisfies this criterion as well.

In fact, with the ULP system, up to 1,000 transmissions from devices may simultaneously and reliably be received by a single Central Access Point. It is possible to serve such a large number of customers because of two interrelated phenomena associated with the On-Ramp system—high protocol efficiency and low overhead requirements. The attached Chart—*Capacity Efficiency Model* (Exhibit No. 1)—illustrates the high protocol efficiency and low overhead requirements of the ULP system and compares these capabilities with FHSS (mesh) systems. ULP's low overhead requirements imply that the capacity of each Central Access Point is maximized to the point where large numbers of users/end-points can be served simultaneously. In other words, data processing capability is available for performing the National Interest Service Vertical functions, and only small amounts will be expended for system "housekeeping." These low overhead requirements mean that the On-Ramp system has been optimized for the

[17] In contrast, mesh systems cannot take advantage of higher antenna elevations because they would be overwhelmed by increased interference at those higher elevation levels.

task at hand—handling low-data rate, small packet size, and modest latency transactions of seconds to minutes. Attached Exhibit No. 3 illustrates the point. We note that a single ULP Access Point (using 1 MHz of spectrum at 2.4 GHz) can serve 17,280 electric meters, 172,800 gas meters, 172,800 water meters, 144,000 streetlights, 288,000 leak detection Nodes, 500 commercial buildings for HVAC monitoring and control, 17,280 blood glucose meters, 28,800 cargo containers, or 4,300 first responder tracking Nodes. In the event additional capacity is required in a given area, Access Points can be configured to use more than 1 MHz of spectrum or stacked in the same location (though on different channels) to provide this additional capacity. Exhibit No. 4 outlines how this can be done to support dense deployment of electric meters, and the concept applies equally to other applications.

The fixed costs per customer associated with Central Access Points is relatively low given the capability of each Central Access Point to serve numerous customers/devices. The only other fixed cost is the cost of network service centers which, by definition, does not vary with the number of customers. Total variable costs of serving customers are small relative to total fixed costs. As customers/devices providing new service verticals are added to each Central Access Point, aggregate revenues increase relative to total fixed costs, a phenomenon that would enable investment in additional Central Access Points, if required to serve an expanding customer base, and permit investors to earn a reasonable return on their investment. In other words, in serving the National Interest Service Verticals, the On-Ramp system is scalable, both technically and economically.

2. The Efficiency of On-Ramp's Network System in Terms of Spectrum Allocation

On-Ramp's system is not only economically efficient, but it is much more spectrally efficient than mesh systems. Specifically, it is capable of achieving a significantly higher data rate per meter per amount of spectrum than mesh.

For any given allocation of spectrum, the true measure of spectral efficiency is how many customer installations/devices could be served. The On-Ramp system not only has the ability to serve a large number of customers/devices with a single Central Access Point, it also is able to expand the number of Central Access Points within a given allocation of spectrum. In contrast, mesh systems are characterized by the opposite phenomenon—adding more infrastructure actually lowers performance unless additional spectrum is used. This means that a far greater number of customers and Nodes can be served using the On-Ramp system within a given spectrum band than is the case with competing technologies.

This phenomenon is well-illustrated by Exhibit No. 1. The exhibit demonstrates that a mesh system would be capable of providing a higher data rate than ULP, *i.e.*, 100 Kbps as compared to 66 Kbps, if allocated 20 MHz of spectrum (as compared to a 1 MHz spectrum allocation to ULP). However, when their respective overheads and protocol efficiencies are factored in, and the systems compared on a throughput per meter per 1 MHz of spectrum basis, ULP is plainly the "winner" in terms of spectral efficiency (22 bps/meter/1 MHz as compared to only .05 bps/meter/1 MHz for mesh). It is important to note that the 22 bps data rate offered by ULP is more than sufficient to meet the needs of the applications and devices represented within National Interest Service Verticals, which require relatively small amounts of data on the order of 100s of bytes to 10s of kilobytes per day per device, and are small packet-size transactions.[18]

[18] *See* Exhibit No. 5.

3. The Superior Scalability of On-Ramp's Network System

Given that On-Ramp's system is both economically efficient in terms of the fixed infrastructure costs required to serve each customer, and spectrally efficient, the On-Ramp system is *scalable*, meaning that it can be economically deployed within a relatively small amount of spectrum to serve an ever-increasing number of National Interest Service Verticals and their respective customer bases.

A Network Deployment Model and Case Study for San Diego County prepared by On-Ramp shows that the system would require lower infrastructure cost and spectrum than mesh systems to service endpoints across vertical applications. On-Ramp has already deployed a network covering 600 square miles (using a single Central Access Point) and conducted a detailed network propagation model proving that 28 Central Access Points can reach 97 percent of endpoints in the region. The cost to deploy and operate the network is several orders of magnitude less than existing technologies. The same study also shows that four million endpoints that would be used in connection with the National Interest Service Verticals could be served within 2 MHz of allocated bandwidth.[19]

E. Unlicensed Spectrum Would Not Be Adequate to Enable the National Interest Verticals to Reach their Full Potential. An Allocation of Licensed Spectrum Is Needed for this Purpose

1. Unlicensed Spectrum Is an Inadequate Solution

ULP can effectively address large scale deployments of *some* vertical market applications *most of the time* with unlicensed spectrum in the ISM bands. However, a deployment strategy based on unlicensed spectrum would limit the current utility and future growth prospects of a regional or national machine-to-machine network whose main purpose is to serve critical

19 On-Ramp San Diego County Network Deployment Model, December 2009.

infrastructure and life safety. This is because the growing multitude of uncoordinated networks and applications operating in the ISM band severely impact reliability.

Unlicensed spectrum is not sufficiently reliable on a national or regional level to support mission-critical applications or those requiring very high quality of service. All wireless networks using unlicensed ISM spectrum are susceptible to intentional and unintentional interference. Although a network based on ULP is far more resilient to interference due to its very large link budget (173dB) and interference mitigation techniques (*e.g.*, channel agility and retransmission protocols), there are still instances where the signal can be jammed and, hence, make network reliability difficult to predict.[20] This persistent potential for interference limits the ability of *any* network operating in the ISM band to support applications requiring 99.99% reliability and uncompromising performance quality, at least without having to make prohibitively high expenditures on facilities, planning and management and using excessive amounts of spectrum.

Even if the signal is not fully jammed, interference can cause unpredictable latency, thereby reducing the speed with which data is transferred through the network. Although this may not significantly affect applications such as automatic meter information ("AMI") services, it potentially disqualifies the use of the network for critical alarms, life safety, location tracking and other time-sensitive applications. Interference can also cause a network to use more power due to the need to be active for longer periods for data transfer. In turn, this can significantly decrease battery life and hence reduce the attractiveness of the business case and value

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[20] For example, a device strategically located near a gateway (ULP or other) in a highly elevated location could intentionally or unintentionally jam a large number of users even if the device is compliant with FCC Part 15. Even when employing channel and frequency hopping techniques, an intentional jamming signal could be employed to jam FHSS and DSSS systems. This problem cannot be solved through network planning, and the available legal remedies under Part 15 would apply, necessarily, only after the fact.

proposition of the network for applications such as water and gas meter AMI that require devices to operate for 10-20 years in the field on an existing battery.

The level of background interference and the potential for jamming will increase over time as the number of devices currently using the ISM bands increases. As a result, the number of applications and end-user devices that a national machine-to-machine network operating in the ISM bands could potentially support will decline still further. The scale of this problem will actually accelerate as the ISM bands become even more crowded, due to a positive feedback loop that forces existing operators using the ISM bands to increase power levels or add additional gateways in order to compensate for increased interference. These actions further increase interference levels, creating an "arms race" that ultimately results in significantly diminished network performance for all parties.

Finally, the potential scale of a regional or national machine-to-machine network is simply so large (*billions* of devices are contemplated) that its uncoordinated deployment in the existing ISM bands would eventually render the entire band effectively unusable for most applications. In other words, the successful proliferation of machine-to-machine applications will ensure the ultimate failure of the supporting networks if the use of spectrum is not carefully coordinated.

In sum, a regional or national machine-to-machine network based on unlicensed spectrum is suitable for a small number of applications at best, rather than the billions of end use devices of National Interest Service Verticals currently envisioned for the network, due to the interference (and potential for interference) and the competition for spectrum that currently are unavoidable traits of the free ISM bands.

2. On-Ramp's Recommendation for an Allocation of Licensed Spectrum

On-Ramp recommends that the Commission allocate licensed spectrum specifically for the use of a regional or national machine-to-machine network to support the National Interest Service Verticals.[21] Coordination in this situation is key because it allows a single network operator to efficiently use a small amount of spectrum to support a very large number of users with predictable (and controllable) network performance guarantees.

Specifically, On-Ramp recommends the allocation of 8 MHz of dedicated spectrum, in two packets of 4 MHz to each of two operators, on a geographic basis—an allocation that will allow each operator to employ four one-MHz channels using ULP technology. Eligible operators would be those who deploy ULP technology or a technology that is capable of achieving equal or better spectrum efficiency, and would be restricted to using the spectrum for the vertical applications and data networking requirements the network is envisioned to support. One deployment strategy would be to reserve one to two MHz for redundant coverage for low-volume mission-critical applications, while reserving the remaining MHz for high-volume applications or for those applications not requiring high quality of service levels. The operator could then control system performance by adding additional infrastructure as needed for expanded network coverage and/or capacity. By virtue of the allocation of the recommended 4 MHz of spectrum, a single network operator could provide coverage to millions of National Interest Service Verticals endpoints in a metropolitan area.

The allocation of two 4 MHz blocks for a competing eligible network operator in each geographical area would enhance competition. Since existing operators can simply add infrastructure to provide additional capacity to serve end-users, allocations to more than two

[21] Voice communications and other wider bandwidth applications would not be supported by this type of spectrum allocation.

operators is not necessary. On-Ramp believes that the benefits of the incremental competition by more than two carriers would be outweighed by the additional encumbrance of the spectrum.

This allocation of spectrum should exclude high data rate, latency intolerant applications that require greater bandwidth. If the high data rate applications were included in the same bandwidth as the low data rate National Interest Service Verticals, the capacity impact from those high data rate applications would degrade the quality of service of the National Interest Service Verticals to an unacceptably low level. Moreover, from a different perspective, cellular and WIMAX systems could improve service to their core customers if they were not also engaged in providing service, within their existing spectrum allocations, to the National Interest Service Verticals.

IV.
CONCLUSION

On-Ramp appreciates the opportunity to submit these supplemental comments. For the reasons stated herein, On-Ramp respectfully submits that the Commission should recognize the extraordinary value of the On-Ramp system to serve the National Interest Service Verticals in a national machine-to-machine network. In light of its scalability—a phenomenon that inheres in its low fixed costs and spectral efficiency—the On-Ramp system is the tailor-made wireless solution to serve these applications. Moreover, On-Ramp's recommendation for a two-carrier geographic model for an allocation of 8 MHz of licensed spectrum is eminently reasonable, consistent with the National interest, and ultimately should be adopted by the Commission.

Respectfully submitted,

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Dated: January 26, 2010

EXHIBIT NO. 1

Capacity Efficiency Model

Application throughput for uplink available for meter data

Uplink Data Rate	Ultra-Link Processing – 1Mhz	FHSS – 20Mhz, 100Khz bandwidth
Uplink Aggregate Data Rate	66 Kbps	100 Kbps
Half-duplex	33 Kbps	Payload dependent (10% - 70% overhead)
Aloha Protocol Max Efficiency	N/A, 33Kbps	18kbps
Engineering Margin/Protocol Efficiency	22Kbps	7 Kbps
After Mesh Inter-device Networking Overhead	N/A, 22 Kbps	1Kbps
1000 meter capacity/1Mhz	22bps/meter/1Mhz	.05bps/meter/1Mhz

EXHIBIT NO. 2

Mesh Does Not Scale Efficiently

Residential Applications

	Electric Meters	Gas Meters	Water Meters	Home Energy	Total
Total Meters	1,400,000	1,300,000	830,000	1,700,000	5,230,000
Required Mesh Repeaters	57,600	205,600			263,200
System Cost Impact	$115M	$113M			$218M
Spectrum	20MHz	5MHz			25Mhz

Plus additional 4.4 million commercial end point devices are not connected

EXHIBIT NO. 3

Endpoint Support Analysis

	Endpoints Supported by Single ULP Access Point (using 1 MHz of spectrum @ 2.4 GHz)
Electric Meters (AMI)	17,280
Gas Meters	172,800
Water Meters	172,800
Streetlights	144,000
Water Leak Detection	288,000
HVAC	500 commercial buildings (Avg. 30K sq. ft. building with 60 sensors)
Blood Glucose Meters	17,280
Cargo Containers	28,800
First Responder Tracking	4,300

EXHIBIT NO. 4

Network Scaling

Ultra-Link Processing™ Scalability
- Electric AMI Example -

Number of Access Points	1	2	3	4
4	69,120 meters	138,240 meters	207,360 meters	276,480 meters
3	51,840 meters	103,680 meters	155,520 meters	207,360 meters
2	34,560 meters	69,120 meters	103,680 meters	138,240 meters
1	17,280 meters	34,560 meters	51,840 meters	69,120 meters

Available MHz of Spectrum (in 2.4 GHz band)

*Note: Given one application requiring 5KB of uplink data each day; plus downlink control and alarm data with less than 12 second latency for alarms

EXHIBIT NO. 5

Utility Network Requirements

	Electric AMI	Gas Meter	Water Meter	Distribution FCI
Daily Uplink Payload Data	5kb +Alarms	500bytes + Alarms	500bytes +Alarms	150 bytes +Alarms
Daily Downlink Payload Data	Network acknowledgement, shut off, rate tables	Network acknowledgment, shut off	Network acknowledgment, shut off	Network acknowledgment, reset
Latency Tolerance	Seconds for alarms; Minutes for payload	Seconds for alarms; Minutes for payload	Seconds for alarms; Minutes for payload	Seconds for alarms; Minutes for payload
Firmware Upgrade	600kb	200kb	200kb	N/A
Battery Requirements	n/a for meter; months to years for HAN devices	15-20 years	15-20 years	10 years